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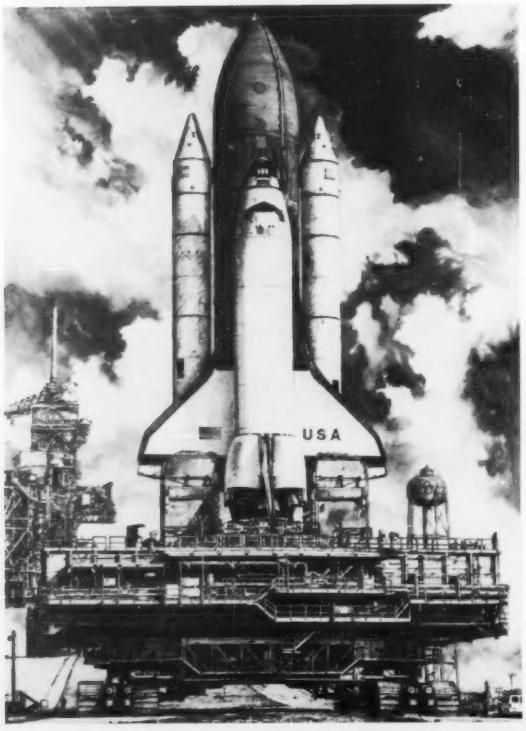
About the Cover

"Coming In," a new NASA watercolor by artist Arthur Shilstone showing a dramatic view of the Columbia as it touches down on the dry-lake bed of the desert after its second flight into space. This new work and the one below are part of a special collection of Space Shuttle art which will be featured at the National Air and Space Museum for approximately eight months, beginning November 30. An article on this show will appear in the Nov. edition of *NASA Activities*. Below is "On the Crawler," a sepia ink sketch drawing with wash on board by artist Chet Jezierski, showing a ground-level view of the fourth Space Shuttle mission rollout.



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Administrator's Column

(In this column *NASA Activities* features an article by NASA Administrator James M. Beggs. These articles focus on subjects chosen by him that address topics of broad interest to the agency's employees.)

Should NASA Fly Private Citizens Aboard the Space Shuttle?

Man's interest in space has always included the desire to travel, explore and understand its vast horizons. NASA has always believed in an open program and has gone to great efforts to keep people informed. Through such media as on-board television, people have traveled into space vicariously. Now a new opportunity is emerging—for people to go themselves, to see for themselves and to share with others. It has long been a desire of NASA to allow private citizens to fly. Now with the United States in possession of the Space Shuttle and with access to space becoming routine, the opportunity for private citizens to fly as passengers deserves careful consideration. This means that the many interrelated questions must be examined before any agency decision can be made. Therefore, I've asked a small task force of our NASA Advisory Council to study these questions and evaluate the options for selecting passengers. I encourage you to help them with their work.

The maximum current Shuttle capacity is seven people for seven days, which would include a standard crew of four: commander, pilot, and two mission specialists. These crew members are and will be NASA astronauts (with the exception of one individual under a European Space Agency/NASA mission specialist training agreement).

The remaining three slots, if not filled by NASA or user-community trained payload specialists, could provide an opportunity for one or more private citizens to travel aboard the Space Shuttle. The requirements they would have to meet would not be as rigorous as those for astronauts.

A diverse range of people have already expressed an interest in flying as passengers: the news media and such correspondents as Walter Cronkite and Jules Bergman, entertainers such as John Denver and the Rolling Stones, film companies, authors, artists, public figures, futurists and the man or woman who is simply determined to go. We can assume that there are many people that we have not heard from yet.

The total number of citizens interested in flying aboard the Shuttle cannot yet be estimated. But one can assume that the figure would be a large one. So the current challenge before the task force is to determine what kind of criteria to apply to pick the relatively small number of private passengers that can be flown. To give you some sense of the enormous size of such a recruitment/selection task, there were almost 3,500 applicants in 1980 who met the rigorous *minimum* qualifications for 19 astronaut openings.

John Naugle, formerly our chief scientist, is heading the group to study the questions raised in selecting private citizens for flight. He contributed to the development of the mission and payload specialist concepts. The members of the task force bring a spectrum of diverse perspectives and expertise to this task: Capt. Richard H. Truly, pilot of the second Space Shuttle mission; Daniel Fink, formerly General Electric's vice president for corporate planning; Sylvia Fries, historian; Willis Hawkins, chairman of the Aerospace Safety Advisory Panel that oversees the Shuttle program; James Michener, an author who has spent a good deal of time understanding NASA and its history; Julian Scheer, who headed public affairs during the early days when NASA's open policy was developed; and Florence Skelly, president of a major marketing research firm noted for its understanding of the American people, their values, expectations and perceptions.

The task force has adopted a working assumption that: (1) there will be a policy of continuing flight opportunities for private citizens; and (2) NASA needs to establish a "fair" policy and selection process that assures a range of passengers who would bring the fullest benefits to the public. And they're looking at the following kinds of questions in trying to determine a selection process that is perceived as "fair":

- What should the objectives for flying private citizen passengers be? What should their flight role be?
- Should they be integrated into the overall mission and be given tasks to perform or fly aboard strictly as observers?
- What would the benefits to the American people or the world at large be if private citizens are flown aboard the Shuttle? Should consideration be given to selecting not only citizens from the United States but from foreign countries as well?
- How do you determine who gets priority in flying?
- What are the medical and training requirements that would be necessary for private citizen flight roles?

The first meeting of the task force was devoted to identifying such questions. Now the group is fact finding with meetings scheduled for NASA's Johnson Space Center, Houston, in October and Kennedy Space Center, Florida, in November. In addition, the group will contact a small number of people around the country who might have data or insights to share. They plan to have their report to me sometime in late winter.

The questions of flying private citizens aboard the Space Shuttle is clearly a complex one. However, when we find the answers that make it possible to fly passengers, these passengers will be taking another significant step for mankind. Clearly they will set a dual historical first: in the mode of conveyance, the Space Shuttle; and in their destination, the reaches of space.

Improved Outlook for Merit Pay

Since my column in the June edition of *NASA Activities*, significant changes have been made in NASA's merit pay system that I would like to update for you. Previously I stated that although funding for merit pay in 1982 would be twice the 1981 level, it was not an effective incentive system for the agency. I indicated that NASA was pursuing an appeal for exclusion from the merit pay law. Subsequent high level discussions have been held between NASA and Office of Personnel Management officials on equitable pay systems between supervisors and nonsupervisors for a research and development work force.

These discussions have resulted in a new flexibility being made available to NASA which allows us to achieve this objective without the long wait for remedial action through legislative changes or by agency exclusion under the Civil Service Reform Act. NASA is now able to determine the dollar amounts awarded to the various merit pay performance ratings; previously these amounts were controlled by the Office of Personnel Management.

Because it appears this policy revision should meet our primary goal of pay increases on a par with the General Schedule, I will not request agency exclusion from the merit pay system at this time. However, I will continue to closely monitor NASA's experience under merit pay until I am satisfied that this system provides an effective incentive plan for the 3,000 management officials and supervisors affected by this system.

Pre-Launch Move—Rollover (top photo) of Space Shuttle Columbia on Sept. 9 from the Orbiter Processing Facility to the Vehicle Assembly Building at NASA's Kennedy Space Center, Fla.

International Satellite-Aided Search and Rescue Saves Three Lives

Three survivors of a plane crash in Canada were rescued through the use of satellite data which helped pinpoint their location. Signals from an emergency transmitter from a downed Cessna 172 in British Columbia were received by a Soviet satellite, COSPAS I (Cosmos 1383), designed specifically for search and rescue work. The information was immediately relayed to Canadian search and rescue units. Satellite location of the crash site was only 22.5 kilometers (13.9 miles) of the downed plane. The timely rescue of the crash victims would have been impossible without the satellite data, according to Canadian authorities.

The COSPAS I satellite is one element of an international cooperative project currently in progress between the United States, Canada, France and the Soviet Union to use low-Earth orbiting unmanned satellites to detect and locate aircraft and ships in distress. Such a network provides greater opportunities to save more lives throughout the world.

In July 1982, the Canadian government conducted a massive but unsuccessful search for a pilot lost in northern British Columbia. The search was estimated to cost $2 million before it was terminated. The father of the missing pilot continued the search using his own resources.

The father, a pilot, and one other passenger failed to return from one of their scouting trips on Sept. 9. The Canadian Rescue Coordination Center at Victoria, British Columbia, was notified that the flyers were missing but that no information was available on their possible whereabouts.

The Center was aware of Canada's participation in an international search and rescue project which had included since its June 30 launch, an orbiting Soviet satellite, COSPAS I (Cosmos 1383). The Rescue Coordination Center called the network ground station for this project at Ottawa to determine if any satellite data would be available to aid in locating the missing party. Satellite passes over that area of British Columbia were expected on Sept. 10, the day after the Cessna and its passengers disappeared.

Data from the COSPAS I satellite pass over the area were processed and an emergency locator transmitter location in British Columbia was detected. A search aircraft was dispatched to the predicted location and almost immediately detected the distress beacon on its radio direction finder; the crash site was soon located. The three missing passengers had survived the plane crash but had been seriously injured. They were evacuated by emergency medical helicopters. The cost of the search was minimal.

Operational checkout of the search and rescue satellite-aided tracking (SARSAT) system with the COSPAS system began Sept. 1 to evaluate the combined system's effectiveness in locating distressed aircraft and ships. This demonstration and evaluation phase is expected to last a minimum of 15 months. The Canadian rescue effort is the first direct application of the satellite network to an actual search and rescue operation and validated the effectiveness of the concept.

A national search and rescue plan adopted by Congress in Sept. 1969 mandated that NASA would use aerospace technology to help develop a system of locating aircraft or ships in distress. In 1970 Congress passed a law requiring general aviation aircraft to carry an emergency locator transmitter (ELT) that would emit a signal automatically under stress of an accident. In 1972 the U.S. National Transportation Safety Board recommended that the Coast Guard and Federal Communications Commission require ocean-going vessels carry an emergency position-indicating radio beacon that could be activated either manually or by immersion in water.

These small, lightweight, shock-resistant self-energizing beacons, broadcasting at 121.5 and 243 Megahertz, and in the future, 406 Megahertz (a new frequency under test), are capable of 48 hours of continuous broadcast. These frequencies are reserved worldwide for aeronautical and maritime distress calls. More than a quarter million ships and planes are equipped with emergency transmitter devices.

For such transmitters to be successful, however, the signals must be received and monitored. The International Civil Aviation Organization regulations require that aircraft making long flights over water monitor for transmissions from ocean-going vessels. No

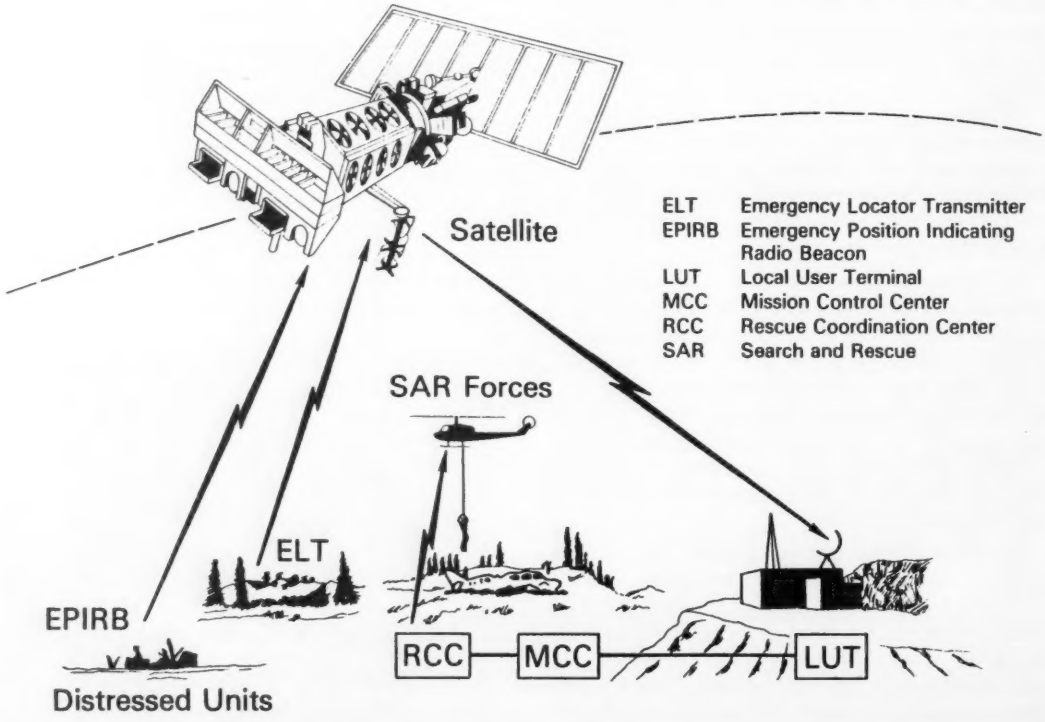
similar monitoring regulations govern flight over land; moreover, even if a passing aircraft has its distress radio turned on, it can only detect these emergency transmitters if it is flying in a direct line of sight with no obstructions. Unless the aircraft is within about 300 km (186.4 mi.) of the distress location, there is little chance of detection.

The use of satellites greatly improves this detection capability. As a low-orbiting satellite passes over these emergency transmitters, it perceives a Doppler shift (change in frequency): a higher frequency when the satellite approaches the transmitter, a frequency that remains identical when the spacecraft is directly overhead, and a lower frequency when the satellite leaves the transmitter. These Doppler data are recovered as an S-shaped curve of frequency versus time. The shape and slope of the curve, together with the location of the satellite at each point of the Doppler curve, are used to locate the emergency transmitter site.

Because a low altitude satellite passing over the North and South poles travels the entire Earth in a 24-hour period, an operational search and rescue satellite-aided tracking system, comprised of three or four satellites, could detect a distress signal anywhere on Earth within a few hours.

In 1976, the Canadian Department of Communication joined the United States to define a joint satellite-aided search and rescue demonstration program called SARSAT (for search and rescue satellite-aided tracking). This joint program was expanded into a trilateral program in Dec. 1977 when the French Centre National d'Etudes Spatiales joined the effort. These nations have cooperatively agreed to build the necessary spacecraft and ground equipment needed to receive and process signals from satellites designed specially for search and rescue as well as maintain search and rescue forces.

Norway (with Swedish participation) and the United Kingdom also have joined SARSAT as "investigators"; other nations are also considering participation in this role. These nations will contribute receiver antennas, ground stations, and user agency rescue efforts, but unlike the United States, Canada, France and the Soviet Union, will not develop or build their own satellites or the necessary spacecraft instrumentation to receive and transmit distress data.



Basic concept of satellite-aided search and rescue.

The SARSAT project is comprised of both space and ground segments. The space segment involves two "guest" instruments aboard three spacecraft of the National Oceanic and Atmospheric Administration's advanced TIROS-N (ATN) satellite series. The first SARSAT-equipped satellite developed by the United States, Canada and France, called NOAA-E, is expected to be launched in February 1983. While in space, SARSAT equipment will be operated by NOAA.

The SARSAT repeater, one of the "guest" instruments provided by Canada will relay distress messages from emergency transmitters now in use directly to Earth, providing real-time coverage. The second "guest" instrument is a signal data processor provided by France.

As part of the SARSAT ground segment, the United States will install, operate and maintain the U.S. Mission Control Center and three ground stations. The ground stations receive the signal directly from the satellite and process the Doppler information to provide the location of the distress signal.

The U.S. Air Force will operate the U.S. Mission Control Center and one ground station, which are located at Scott Air Force Base, Illinois.

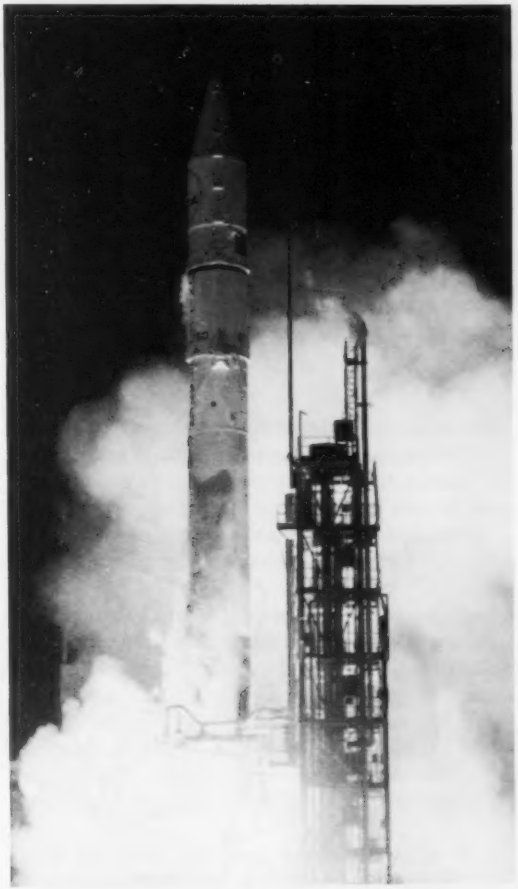
The U.S. Coast Guard will operate the two other ground stations, one at Point Reyes, Calif., and one at Kodiak, Alaska. The U.S. ground stations will provide regional coverage of the 48 contiguous states, Alaska, part of Canada, Mexico, and coastal maritime areas. A Canadian ground station, in Ottawa, will extend this coverage to the eastern North American continent. A French ground station in Toulouse, France, will provide coverage of France and much of Europe and its coastal areas.

Parallel to the SARSAT project is the Soviet Union's compatible search and rescue satellite program, COSPAS. In a 1980 agreement, the Soviet Ministry of Merchant Marine was designated to coordinate its program with the SARSAT program.

COSPAS will fly receivers on Soviet satellites and coordinate its launches with those of the National Oceanic and Atmospheric Administration to provide complete world coverage. The compatibility between these two projects allows the SARSAT ground stations to use the COSPAS satellite when it is in view and vice versa.

Ground stations at Moscow, Archangelsk and Vladivostok will track both SARSAT and COSPAS satellites. The Soviet Union will maintain communications with SARSAT nations through the U.S. Mission Control Center.

On Sept. 29, NASA's Goddard Space Flight Center, Greenbelt, Md., conducted a successful demonstration test of the COSPAS/SARSAT project. As COSPAS I flew within range of Goddard, two emergency transmitting devices were beaming distress signals. On the spacecraft's orbital pass, coordinate information for the signals was relayed pinpointing their location. This data was processed at Goddard; if these beacons had been an actual plane or ship in distress, a rescue effort would have been dispatched immediately. U.S. participation in the COSPAS/SARSAT project is managed by the Communications Division of NASA's Office of Space Science and Applications; technical implementation of the project is under the direction of NASA's Goddard Space Flight Center, Greenbelt, Md.



September's Launch—Successful liftoff of Intelsat V-E on Sept. 28 from Eastern Space and Missile Center, Fla., aboard an Atlas Centaur launch vehicle. Liftoff time was 7:08 p.m. EDT.

Spacelab 1 Flight and Back Up Payload Specialists Named

NASA and the European Space Agency (ESA) have named their prime and back-up payload specialists for the first Spacelab mission, SL-1, scheduled for launch on Sept. 30, 1983, on the ninth Space Shuttle mission.

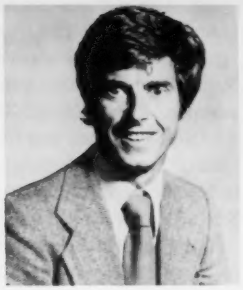
NASA has assigned Byron K. Lichtenberg, a biomedical engineer, and ESA has assigned Ulf Merbold, a West German physicist, as onboard payload specialists. The second American, Michael Lampton, a physicist, and the second European, Wubbo J. Ockels, a Dutch physicist, will act as flight back-ups and will be deeply involved with payload operations from the ground throughout the duration of the mission.

All four men have been in training for the Spacelab 1 mission for the past four years. A laboratory module and one pallet will be used for this mission. Other configurations of Spacelab units can be used for future missions.

The full crew for the ninth Space Shuttle mission consists of Ulf Merbold and Byron Lichtenberg, payload specialists; Owen Garriott and Bob Parker, mission specialists; and John Young and Brewster Shaw, commander and pilot respectively. Orbiter vehicle will be the Challenger.

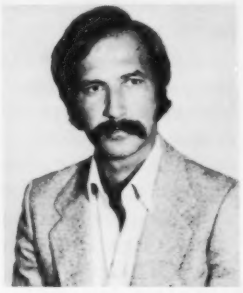
Merbold and Lichtenberg will perform experiments aboard Spacelab using 38 different scientific packages (experiments and experiment facilities) both inside the habitable module and on the pallet. In this role, they will represent more than 70 different scientific investigators from Europe, Japan, and the United States.

Byron K. Lichtenberg

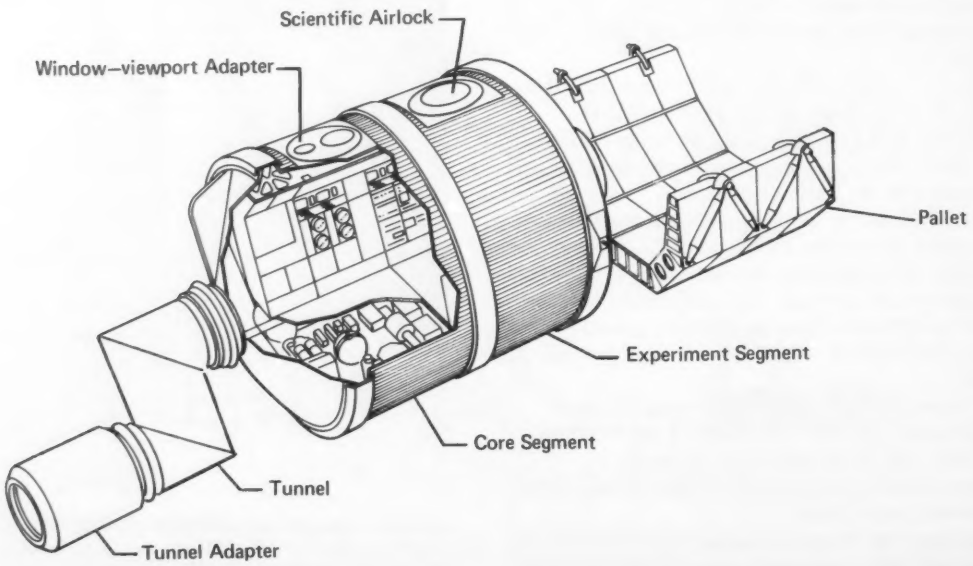


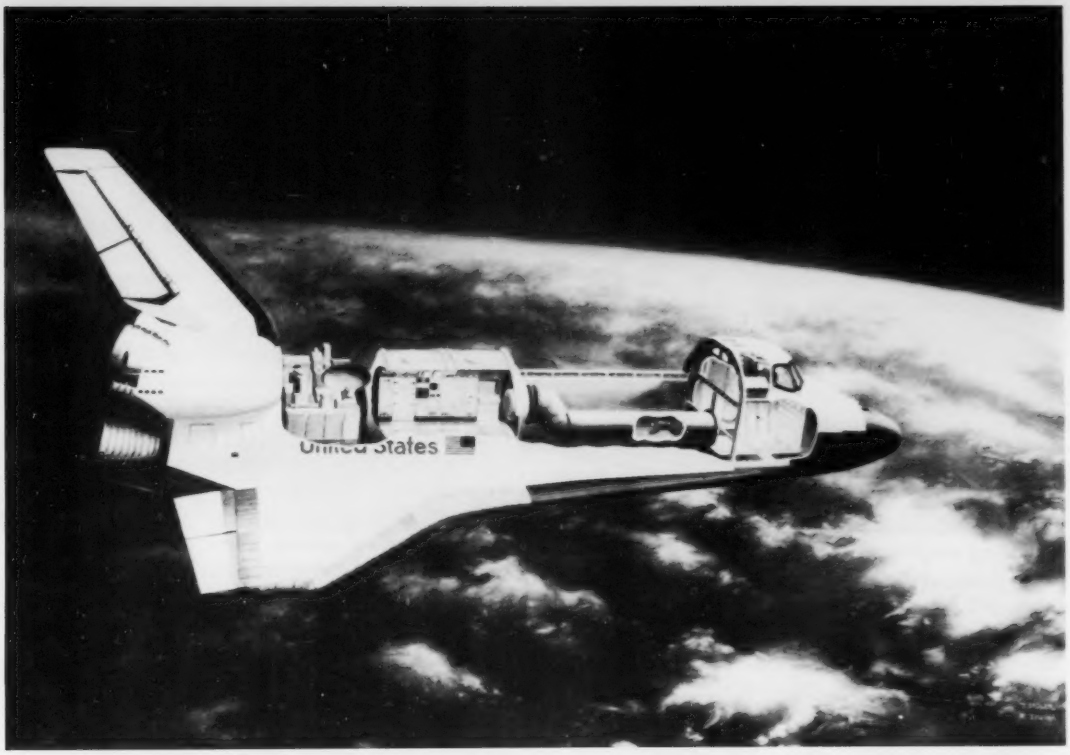
Ulf Merbold

Michael Lampton



Wubbo J. Ockels





Spacelab 1 configuration (opposite page) consisting of one laboratory module and one pallet. Top photo shows artist's concept of Spacelab 1 aboard the Space Shuttle.

The Spacelab 1 mission experiments were developed by scientific institutes in the ESA member states—Austria, Belgium, Denmark, France, Germany, Italy, the Netherlands, Spain, Sweden, Switzerland, the United Kingdom—and in Japan and the United States.

Since January 1982, the payload specialists have been undergoing mission operational training in the Payload Crew Training Facility at the NASA Marshall Space Flight Center, Huntsville, Ala., where they are faced with operational situations very similar to those they will encounter during the Spacelab-1 flight. They are, in this way, gaining considerable experience before the launch, thus ensuring a maximum scientific return from the flight.

In December 1977, ESA selected Ulf Merbold, Germany, Claude Nicollier, Switzerland, and Wubbo Ockels, the Netherlands, as payload specialist candidates from among some 2,000 European applicants. Since January 1978, they have been preparing for the Spacelab 1 mission. During their training, which has been carried out in Europe, Japan and in the United States, the payload specialists have acquired an in-depth knowledge of the individual experiments comprising the first Spacelab payload and will thus be in a position to operate and monitor them closely and to execute minor repairs or adjustments which may be required during the flight.

During this period, Claude Nicollier was assigned to undertake mission specialist training and, as a result, was no longer considered a European payload specialist. He is now a candidate for a mission specialist position on the German Spacelab mission, D-1, scheduled for launch in mid-1985. Moreover, ESA's back-up payload specialist for Spacelab 1 automatically becomes a member of the payload specialist team training for D-1.

In May 1978, Michael Lampton, University of California at Berkeley, and Byron Lichtenberg, Massachusetts Institute of Technology, Cambridge, were selected by the Spacelab 1 Investigators Working Group (IWG), to be the American payload specialists.

Human Rhythm Cycles Studied by NASA Scientists

The conditions of space flight—weightlessness, rapid shifts in light/dark cues and social isolation—have been found to disrupt the body's circadian (24-hour) rhythm cycles. Understanding the effects of these conditions is important because such conditions on Earth have been associated with boredom, irritability, negative moods and withdrawal. Upsetting of daily body rhythms also may cause fatigue, decreased performance, insomnia, anxiety, gastrointestinal and other physical symptoms.

Scientists at NASA's Ames Research Center, Mountain View, Calif., led by physiologist Dr. Charles Winget, are studying human rhythm cycles in preparation for NASA's extended Space Shuttle missions where small groups of people will be subjected to these conditions. Winget has studied circadian rhythm in groups placed in social isolation, in shift workers and in humans subjected to prolonged bedrest (a means of simulating weightlessness on Earth.)

On Earth most humans maintain a basic 24-hour cycle, undisturbed until a crossing of time zones (jet lag), an alteration of work hours or a late night disrupts the cycle. Upset rhythms then cause problems with physical health, emotions, behavior, sleep, altered responses to medication and decreased performance. Many people are more susceptible to colds, viruses and infections when their rhythms are disrupted and headaches and intestinal disturbances are more common.

Daily rhythms are linked to the light/dark cycle of Earth, which sets these internal rhythms. Rhythms appear to be a natural function of cell-formation cycles in the body; cancer cells are the type that do not exhibit rhythms.

Pulse rate, blood pressure, heart rate, temperature, kidney function, metabolism and hormone secretions all follow a pattern and rhythm. The first three are lower at night. Temperature is low in the early morning and high in the late afternoon; most people perform best when their temperature is highest, usually about 3 p.m. Kidney function is high during the day and low at night. Metabolic activity is highest at noon. Adrenal rhythms vary, but are higher during early sleeping hours.

Drugs and alcohol affect the body differently at various times of day. The same amount of alcohol taken early in the morning will result in a higher blood-alcohol level than if taken at about 4 to 5 p.m.—the optimal time for alcohol consumption. Medications, like alcohol, vary in their effect depending on the time of day administered. An oral dose of antihistamine given at 7 a.m. will last 15 to 17 hours, but given at 7 p.m. will last just six to eight hours. Digitalis (a heart medication) has twice the effect when given at night. Drugs can be given in lower doses if properly timed—especially important for powerful cancer medicines with strong side effects. A new field of biology, called chronopharmacology, was developed by Winget and others to study the effects of drugs administered at different times of the day.

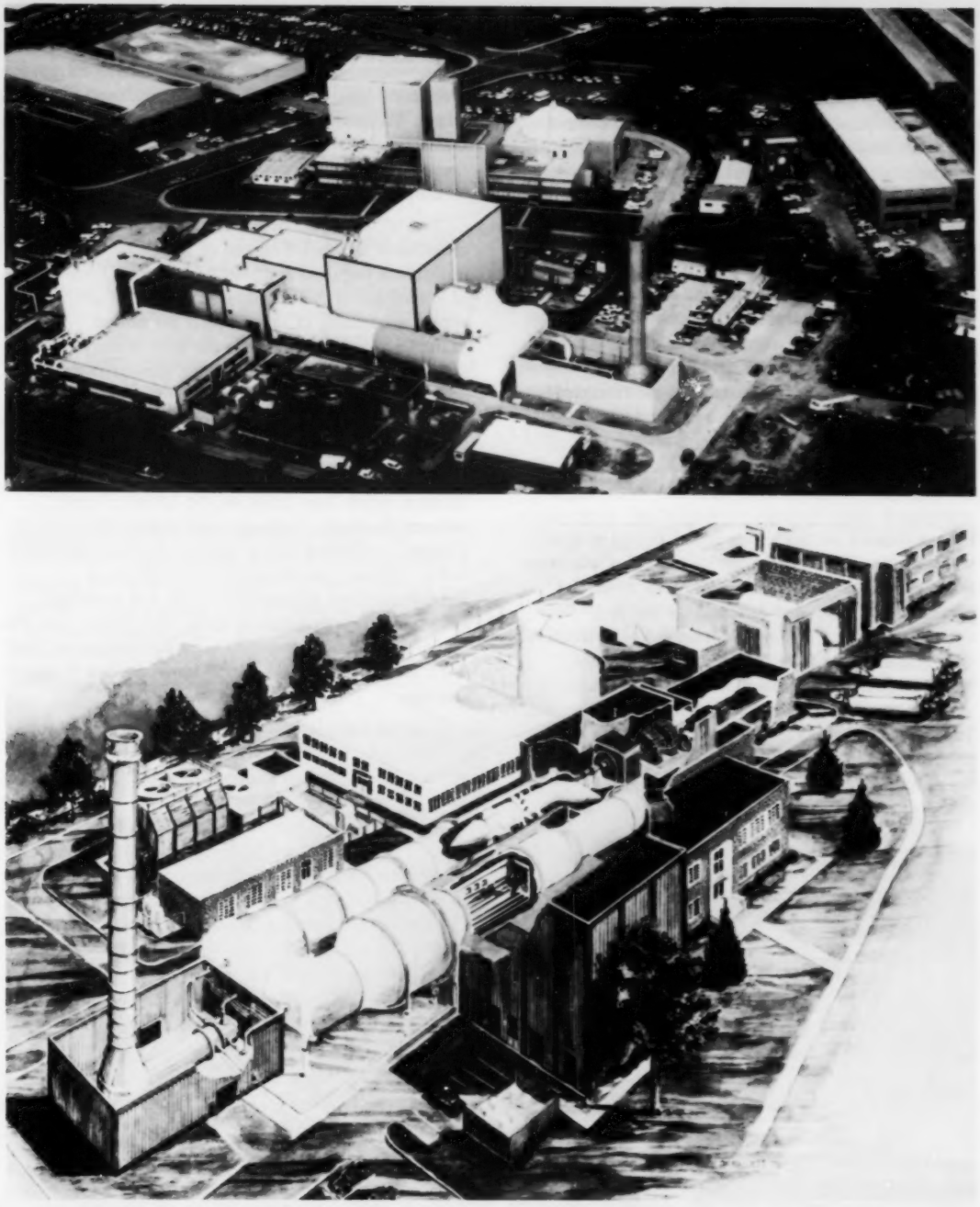
Emotional and psychiatric disorders are also associated with upsets in circadian rhythm. Experimental subjects have reported a deep sense of depression and hopelessness within 72 hours of a shift in circadian patterns. Most individuals react to circadian disturbances with lowered self-esteem. Psychological problems may be associated with sleep difficulties, which are a side-effect of circadian disturbance. When sleep stages are altered, the individual may sleep for an adequate number of hours but the altered rhythm of sleep leaves him unrefreshed, listless and vaguely uncomfortable.

In experimental subjects, temperature and brain waves became abnormal during circadian disruptions and neither measure returned to normal in less than two weeks. Winget concludes from these and other findings that work schedules should not be shifted more often than every three weeks. Otherwise the worker is continuously deprived of normal, health-giving sleep patterns, and performance and safety awareness inevitably decrease.

Studies of humans isolated in small groups have shown that social interaction affects rhythm. Rhythms for individuals in a small group tend to synchronize together and change when new individuals are introduced into the group.

Winget recommends the following guidelines for coping with an upset circadian rhythm:

- Perform the most important tasks as soon after waking as possible.
- Avoid working with power tools or driving a vehicle when feeling sleepy or disoriented.
- Eat the largest meal of the day as soon as possible after waking.
- Decrease caloric intake slightly and avoid overloading the system with food.
- Decrease intake of salt, coffee, beer, wine and hard liquor. Caffeine can help increase performance, but only when taken at peak times—such as the high point in the temperature cycle.
- Use only prescribed medications. Amphetamines and sleeping pills won't help, because of their "hangover" effect and because they disturb "REM"—Rapid Eye Movement—sleep (dreaming), which is important to human psychological well-being.



NASA's Newest Wind Tunnel—Nearing completion is the National Transonic Facility, a cryogenic wind tunnel at NASA's Langley Research Center, Hampton, Va., designed to test aircraft in the high pressures of transonic flight. Calibration checkouts of the tunnel are scheduled to begin in January 1983 with full-scale operation to follow a few months later. The facility will be shared equally between NASA and the Department of Defense. Bottom photo shows artist cutaway view of the facility.

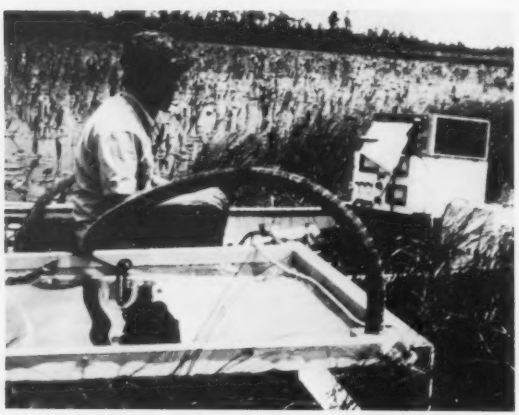
Scientists Find "Clean" Air Is Not So Clean

Fresh farm, mountain, and ocean air may not be as clean as once thought. This air is part of the Earth's lower atmosphere—the troposphere—which composes approximately 80 percent of the planet's total atmosphere. Recent studies of trace gases in this region have revealed relatively high concentrations of carbon monoxide, ozone, and aerosol particles, all pollutants.

Also, scientists suspect other trace gases in this region, particularly methane and ozone, could affect the region's atmospheric chemistry and possibly reduce the amount of heat the Earth radiates back into space—a process which, in turn, contributes to global warming. In addition, man's activities may impact the composition of this region. Methane, for example, is produced both naturally and as a by-product of man's activities.

Relatively little is known about the composition of the troposphere, how it evolved or how man may be changing it. Most research on atmospheric composition has not focused on this region where airplanes fly or where weather develops but on studies of industrialized urban areas and on the stratosphere (the upper 20 percent of the gases that surround the Earth).

However, a recent symposium on the composition of what researchers call the "non-urban troposphere" brought nearly 200 representatives from industry, universities and government together to exchange ideas. The symposium, held at Williamsburg, Va., was co-sponsored by the American Meteorological Society, the American Geophysical Union, and NASA. Nearby NASA Langley Research Center, Hampton, Va., contributed more than 10 percent of the 112 technical presentations. Other NASA installations that contributed to the symposium were the Ames Research Center, Mountain View, Calif.; Wallops Flight Center, Wallops Island, Va.; and Goddard Space Flight Center, Greenbelt, Md. The Langley presentations included new findings about three environmentally significant gases: methane, carbon monoxide and ozone.



NASA Langley's Dan Sebacher makes a methane flux measurement in the Okefonokee Swamp in Georgia. Production of the gas was found to vary greatly from one wetland area to another and even within a single wetland area.

"Not until the past decade," said symposium coordinator Dr. Jack Fishman of Langley, "have researchers begun to appreciate the potential importance of a trace gas in the troposphere (a gas that might appear in amounts of several parts per billion, for example). Also, researchers have only recently developed instruments with enough sensitivity to accurately measure certain gases in trace amounts."

Randy Cofer of Langley's Field Experiments Branch reported the presence of more methane in the Northern Hemisphere than the Southern Hemisphere. Data taken during a month-long cruise on the Atlantic Ocean between Hamburg, Germany, and Montevideo, Uruguay, confirmed earlier studies. Another conclusion is that methane concentrations in the Northern Hemisphere have increased since the first systematic measurements were taken in 1970. This finding was also supported by other presentations at the symposium, and scientists suspect that the increase may be due to man's activities.

Scientists have long assumed that the primary sources of atmospheric methane are natural, coming from wetland areas (swamps and marshes) and, to a lesser degree, from cows and other ruminant animals that give off the gas in the process of digestion. A group of Langley researchers, led by Dr. Robert Marrias, presented evidence at the symposium that may cause thinking in this area to be reevaluated. Through a series of ground-based measurements, they found two things: there can be enormous variation in the amounts of methane produced from one wetland area to another and even within a single wetland area, and wetlands may contribute much less of the global methane than was previously estimated.

These results, vigorously debated at the meeting, documented the complexity of the ecosystem in which methane is naturally produced and suggest that man's activities may disturb the natural methane cycle much more than was previously thought.

Another Langley experiment discussed at the symposium concerned measurements of atmospheric carbon monoxide, ozone, other trace gases and aerosols (tiny particles suspended in the air). The measurements were taken from an airplane flown off the East Coast of

the United States in the summer of 1981. An orbiting satellite had identified a plume of air that originated over the eastern United States extending approximately 2,000 kilometers (about 1,250 miles) over the Atlantic. Researchers flew the airplane into and over the plume. When they flew through the plume, they took direct measurements of carbon monoxide and ozone; when flying over the plume, they used remote sensing devices to measure ozone and aerosol concentrations.

Team spokesman Dr. Ed Browell reported that the plume extended up to 2 km (1.2 mi.) in altitude and contained relatively high concentrations of carbon monoxide, ozone and aerosol particles. All three are considered pollutants in the lower atmosphere. In essence, their close-up look confirmed the location and overall size of the plume as indicated by satellite readings. The satellite instrument, however, is only capable of "seeing" aerosols.

A by-product of the dual set of airplane measurements (through and over the plume) is that the capability of an advanced laser remote sensing instrument, developed by Browell's team, was successfully demonstrated. The instrument proved that a sensing device does not need to be flown through a plume to take accurate measurements of ozone and aerosol concentrations.

In November 1981, a Langley instrument for the remote sensing of carbon monoxide flew aboard the second flight of the Space Shuttle and took the first measurements from space of a trace gas in the lower atmosphere. Results of the experiment—Measurement of Air Pollution from Satellite—were presented for the first time at the symposium. Data quality was exceptional and exceeded all expectations. Dr. Henry Reichle of Langley's Chemistry and Dynamics Branch presented measurements of carbon monoxide from selected orbits. The MAPS instrument literally "mapped" the location of strong gradients of carbon monoxide (where low concentrations meet high concentrations) down to 100-km (60 mi.) areas or less. This high resolution allowed the Shuttle-borne experiment to define relatively small regions of carbon monoxide in elevated concentrations.

Updated Stirling Engine Concept Used As Solar Energy Device

Concentrated sunlight may be the energy source used in the future to supply power to small communities or remote villages not connected to an electric utility grid.

Fifth Space Shuttle Crew and Insignia—Flying aboard the Space Shuttle Columbia for her fifth mission, scheduled for launch Nov. 11, will be a four-member crew. From left to right are: Joseph P. Allen, mission specialist; Vance D. Brand, commander; Robert P. Overmyer, pilot; and William B. Lenoir, mission specialist. Official crew patch for the fifth flight of the Space Shuttle (note five points of star). This mission is the first operational flight following four successful orbital test flights.

A system tested by NASA's Jet Propulsion Laboratory (JPL) engineers in the California desert used solar radiation to drive an engine which, in turn, was used to generate a daily (sunrise to sunset) average of 250 kilowatt hours of electrical energy (enough to power 8-10 average homes). Power from the system was fed into the Southern California Edison utility grid; peak power output measured 23.5 kilowatts.

For this test, JPL engineers combined a technologically updated Stirling engine with a dish-shaped solar collector/concentrator. The Stirling engine, named for its 1816 inventor, Scottish minister Reverend Robert Stirling, is a 166-year-old closed cycle concept that can be powered by any external heat source. The JPL experiment is part of the Department of Energy's program in solar thermal technology.

The parabolic dish/Stirling engine system demonstrated an unusually high level of efficiency—29 percent, a milestone for solar conversion systems. (Efficiency is defined as the system's electrical output divided by the amount of solar energy collected.) Evaluation of solar concentrator dishes combined with a Stirling engine to produce electricity has been under way since 1979 at the JPL test site at Edwards Air Force Base, Calif.

Tests to date have used a test bed solar concentrator designed specifically for experimental research. The 11-meter (36-foot) diameter dish is constructed of 224 individual mirrors mounted on a steel truss framework. Solar radiation striking the mirrors is focused into the aperture of a receiver suspended above the center of the dish. This aperture is 20 centimeters (8 inches) in diameter. The receiver takes this concentrated radiation

Solar energy conversion system which uses concentrated sunlight to drive a Stirling engine. The mirrored parabolic dish focuses the sunlight to drive the engine, suspended in the housing above the dish. The Stirling engine supplies the mechanical power to drive an electric generator. The system fed an average of 250 kilowatt hours of electrical power during the day into the Southern California Edison utility grid from a test site in the California desert.

and converts it into heat at 700 degrees Celsius (1,300 degrees Fahrenheit), which is used to power a Stirling engine. The engine supplies the mechanical power to drive an electric generator.

Testing of the Stirling engine with the test bed concentrator is managed by JPL for the Department of Energy through a contract with NASA. United Stirling, Inc., a U.S. subsidiary of United Stirling of Sweden, designed, adapted and built the engines for use on solar dish concentrators.

In order to carry forward the research on the solar Stirling engine concept, the Department of Energy has a cooperative agreement with Advanco Corp., El Segundo, Calif., to develop a complete parabolic dish/Stirling engine system over the next two years. JPL serves as the technical monitor for this effort managed by the Department of Energy's Albuquerque operations office. This effort includes a new lower-cost concentrator of a design suitable for use in a system that could become a commercial product in the future.

In late 1983, a new parabolic dish/Stirling engine module will be installed and tested at one of Southern California Edison's Palm Springs facilities. According to Dr. L.T. Papay, Edison's Vice President of Advanced Engineering, the utility views solar energy projects, such as the dish/Stirling engine power system, as a keystone in Edison's 10-year commitment to the accelerated development of alternate and renewable energy sources in this decade.

Dr. Vincent Truscello of JPL is the technical manager of dish/electric projects with program management by the Department of Energy's Albuquerque operations office.

Halley's Comet Watch Network Formed

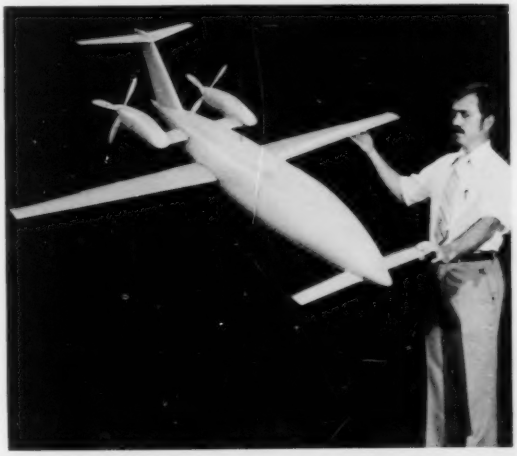
An international network of scientists is being organized to observe Halley's Comet as part of a coordinated program when the comet passes Earth in 1986. The organization, called the International Halley Watch, will be led by Ray Newburn, cometary science team leader at NASA's Jet Propulsion Laboratory, Pasadena, Calif., and Jurgen Rahe, director of Remeis Observatory (Bamberg) of the University of Erlangen-Nurnberg, Erlangen, Federal Republic of Germany. The Watch invites all Halley's Comet observers, professional or amateur, to share their data with the networks now being created.

Ground-based observations along with those of balloon, air borne and earth-orbital instruments will be collected by the International Halley Watch. Data compiled by the Watch will form the Halley Archive, the largest collection of information ever produced on a single comet.

Japan, the Soviet Union and the European Space Agency are each sending spacecraft to encounter the comet in 1986, and plan to supply their scientific results to the Halley Archive.

Experiment teams supported by the International Halley Watch will study the comet using seven general techniques:

- Large-scale phenomena studies will use wide angle photography to study the comet's tails.
- Near-nucleus studies, using high-resolution photographic and electronic imaging of the coma, will yield data on the nucleus, its rotation rate, surface structure and the comet's general activity.
- Spectroscopy and spectrophotometry will provide data on the physical composition of the nucleus, coma and tail.
- Photometry and polarimetry will determine the abundances and distribution of volatile and non-volatile components of the coma and tail.
- Radio science experiments study the chemical composition and kinematics, or motion, of the coma, nucleus and tail, searching for chemical species not



Commuter Aircraft of the Future?—Model being used in wind tunnel tests at NASA's Langley Research Center, Hampton, Va., to investigate stability and control in low-speed flying situations. The concept is called "three surface" because it has a forward canard, main wing and rear horizontal tail. The long, slender main wing is designed to be fuel efficient. The aft-mounted engines do not interfere with the wing lift and the design promises less cabin noise. From its nose-mounted horizontal wings to its rear-mounted twin prop engines this one-seventh scale model represents some of NASA's latest thinking about the shape of things to come in commuter aircraft.

discernable in optical wavelengths. Radio experiments will also detect thermal emissions from solids and perform studies of plasmas.

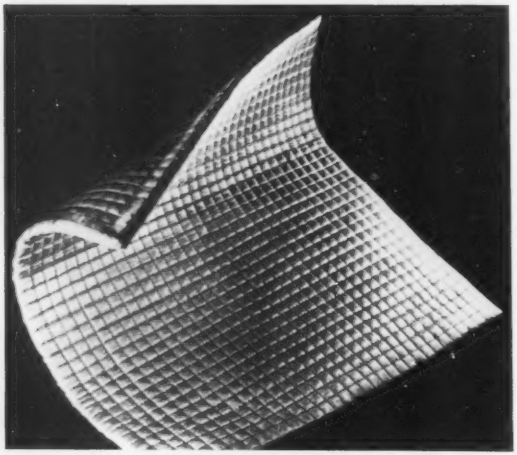
- Infrared spectroscopy and radiometry will determine the temperature, size and composition of dust particles released by the comet. Gaseous components also may be identified.
- Astrometric observations—studies of Halley's position in relation to stars—will provide information on the comet's orbit and ephemeris. The observations will also help determine what effect outgassing of ice from the nucleus has on the comet's velocity.

The efforts of amateur astronomers will be coordinated by the International Halley Watch to complement those of professionals.

Amateur visual and photographic observations will be compared with those of the 1910 apparition of Halley. Spectroscopy and photoelectric photometry of the comet obtained by amateurs can provide supplementary coverage of Halley in cases of weather interference at major observatories.

Amateur studies of meteors during the Halley apparition will be especially helpful, since few professional astronomers devote time to meteor observations. The Eta Aquarid Meteor shower in May 1986 and the Orionid Meteor shower in October in the same year are believed to originate from Halley.

The International Halley Watch office at the Jet Propulsion Laboratory is funded by NASA, and the Bamberg office is supported by the Federal Republic of Germany.



Protective Quilt—Latest in thermal protection material to be added to the Space Shuttle is this silica glass quilt called Advanced Flexible Reusable Surface Insulation developed by NASA's Ames Research Center, Mountain View, Calif., and produced by Manville Building Materials Corp., Denver. This quilt is tougher, lighter and cheaper than earlier tile heat shields. This material, installed over a 20 square-foot area of Columbia's elevon cove, will cover a larger area on Challenger, the second Space Shuttle currently undergoing flight readiness work at NASA's Kennedy Space Center, Fla.

NASA's Electric Rocket Engine to be Tested on Air Force Satellite

A NASA developed solar-powered electric propulsion system may become the satellite auxiliary propulsion system of the future, replacing traditional chemical and gas systems. Lighter in weight than other systems, it can save hundreds of kilograms of weight which could translate into lighter satellites or satellites of the same weight but carrying additional payload such as revenue-producing communications channels. Advantage of the system increases with increasing satellite weight and longer missions.

Pioneered by NASA's Lewis Research Center, Cleveland, the ion auxiliary propulsion system, an electric rocket engine, will be flight tested aboard an Air Force research satellite to evaluate how well it functions in the company of other space hardware. The three-year flight test is designed to qualify the system in space for performing such auxiliary propulsion functions as stationkeeping, attitude control and orbit maneuvering of the spacecraft.

Developed to provide highly fuel-efficient, long-duration, low-thrust propulsion for many applications on space vehicles, the Lewis electric rocket engine recently completed an 11-year-long test in space to verify its durability and operational reliability under space conditions.

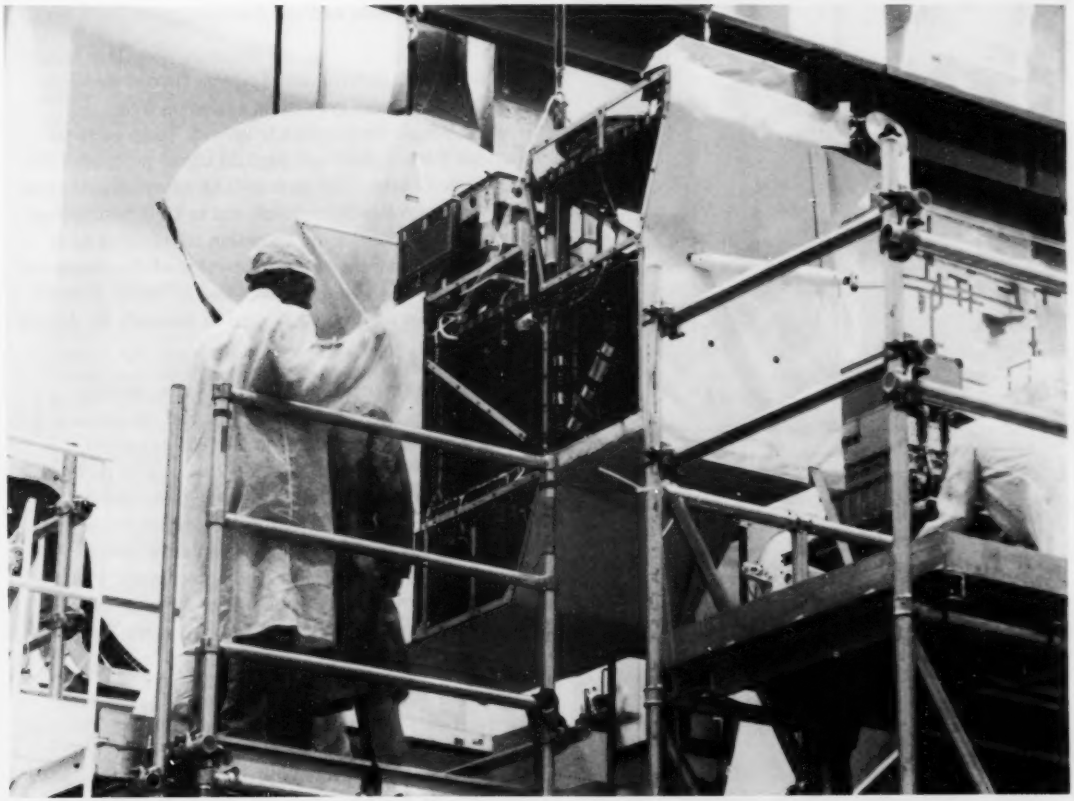
In operation, the mercury ion thrusters of the system are powered by the satellite's solar cells which convert sunlight into electricity for spacecraft power. A power electronics unit converts this spacecraft power into currents and voltages needed to operate the thrusters. With this electric power, mercury atoms in the thruster are bombarded with free electrons producing positively charged mercury ions.

At the aft end of the thruster are two metal screens, with a 1,500V potential drop between them. As the mercury ions pass through the screens, they are accelerated to speeds of 30 km/sec and exhausted along with electrons creating a thrust-producing beam. Some of these exhaust products stray and can come in contact with the satellite's solar array as well as with instruments mounted in the proximity of the system's thruster.

These space tests will determine what effect, if any, this efflux will have on other satellite components. It will also verify that the 8-cm ion auxiliary propulsion system can perform as expected in the role of a satellite stationkeeping device over very long periods of time.

The thrusters are sized to be directly applicable to stationkeeping of communications satellites that weigh about 1,000 kilograms (2,200 pounds) and have seven to 10-year lifetimes. The flight test will duplicate the thruster operation requested for such applications by operating through 2,500 on-off cycles and more than 7,000 hours operation in a 20-month period. Commands from the ground will be initiated at the Lewis Center, relayed to selected Air Force ground stations, and then transmitted to the satellite during its 10-minute passes over ground stations. The two thrusters will be mounted on the satellite in close proximity to a number of diagnostic instruments. The instruments will measure the interactions of the discharge from the thrusters—principally ionized and neutral mercury—with nearby spacecraft elements. The data will make it possible to estimate the magnitude of these interactions with operational space vehicles.

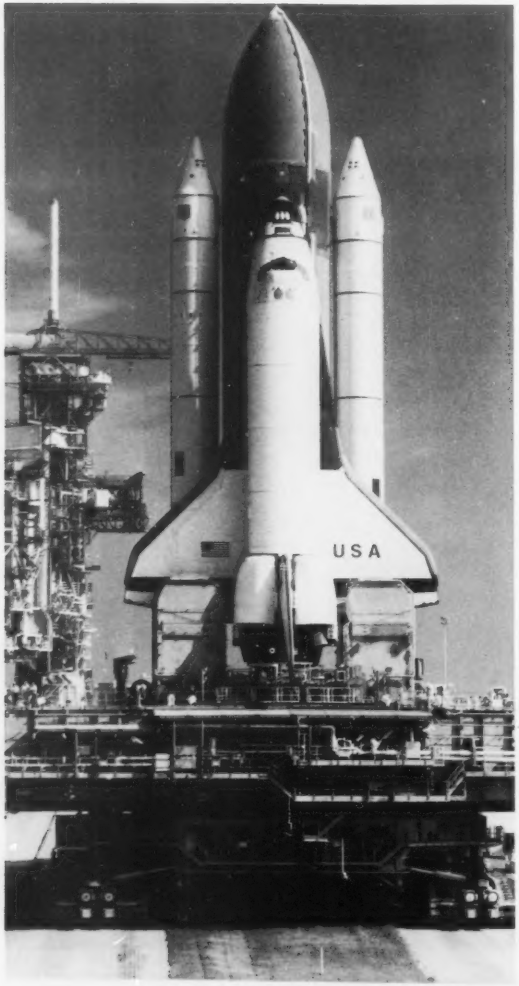
While 8-cm thrusters are suitable for spacecraft stationkeeping applications, 30 cm and larger thrusters, employing the same technology, have been developed and verified in ground tests. These larger thrusters are sized for use in orbit raising, attitude control and maneuvering of large space structures contemplated in future NASA programs. The long-life, low-thrust, fuel-efficient characteristics of electric propulsion make it attractive for controlling and manuevering large, relatively fragile bodies in space.



Spacelab Work—Workers in NASA's Kennedy Space Center Operations and Checkout Building carefully measure the fit of the European Space Agency (ESA) Bridge Assembly, which will carry several ESA experiments, with the pallet that will carry it into orbit as part of the first mission of Spacelab, scheduled for the ninth Shuttle mission in Sept. 1983.

The same characteristics also make electric propulsion attractive for propelling interplanetary payloads in exploration of the solar system. The ion auxiliary propulsion systems' flight test will serve to verify feasibility and readiness of technology elements useful in all these applications.

Hughes Aircraft Co., El Segundo, Calif., built the Ion Auxiliary Propulsion System under contract to Lewis. The Air Force spacecraft contractor is Rockwell International, Seal Beach, Calif.



Number Five—Rollout of the Columbia to launch pad 39A on Sept. 21 for the fifth launch scheduled for Nov. 11.

Contractor News

NASA has awarded a $21 million cost-plus-fixed-fee contract to **United Technologies Corp.,** Power Systems Div., South Windsor, Conn., for development of technology for multi-kilowatt on-site fuel cell power plants. Three specific components of fuel cell power plant technology will be investigated: the fuel processor, the fuel cell stack and the electrical inverter. The initial effort, covering 15 months, will cost $4.2 million. Duration of the contract is for six years. The fuel cell power plants in this program are larger terrestrial versions of the systems used to generate electricity in the nation's manned space program. Multi-megawatt fuel cell systems are also being developed for use by electric utilities for electrical power generation. The contract was awarded under the Department of Energy's Phosphoric Acid Fuel Cell Systems Program managed by NASA's Lewis Research Center, Cleveland.

And from NASA's Kennedy Space Center, Fla., three contract extensions and one contract option have been awarded:

TRW Inc., Defense and Systems Group, Redondo Beach, Calif., was granted an extension to a cost-plus-fixed-fee contract to provide spare parts for payload interrogators and payload signal processors for the Space Shuttle. The parts will be manufactured at the TRW plant in Redondo Beach and in Colorado Springs, Colo. The amount of the extension is valued at $4.6 million, bringing the cumulative value of the contract to $5.8 million. The contract calls for the spare replacement units to be delivered to Kennedy by August 1984.

Rockwell International Corp., Space Systems Group, Kennedy Space Center, Fla., an extension to a Space Shuttle processing contract. The extension, valued at $94.6 million calls for Rockwell to perform normal processing functions to prepare the Shuttle orbiters for launch at Kennedy: preparation of the orbiters, main engines and other hardware during pre-launch, launch and post-landing activities. The cost-plus-award-fee extension brings the total value of the contract to $416.5 million and covers the period from March 31 through Dec. 31, 1982.

Martin Marietta Corp., Denver, Colo, has been awarded an $11.5 million contract extension to perform external tank processing operations for the Space Shuttle. The cost-plus-award-fee extension covers the period from April 1 to Dec. 31, 1983. The cumulative value of the contract totals $54.3 million. Martin Marietta will provide for planning, control and performance activities which ensure the external tank

and associated support equipment operate within specifications.

Boeing Services International, Kennedy Space Center, Fla., has been awarded a one-year contract option to provide supply and transportation services to NASA's Kennedy Space Center. This option, in the amount of approximately $12 million, covers Boeing's work until June 30, 1983. Included in this work will be provisioning, acquisition accountability, inventory management, receipt storage and distribution of materials and equipment at Kennedy, and selected activities at Vandenberg Air Force Base, Calif.

Patents for Inventions from NASA Research

The Office of General Counsel, NASA Headquarters, announces that the following U.S. patents have been issued by the U.S. Patent and Trademark Office to NASA for inventions resulting from NASA research. Inquiries concerning them should be directed to the attention of the NASA Patent Counsel of the indicated installation.

Bruce A. Banks, Michael J. Mirtich, and James S. Sovey, NASA/LeRC	Improved surface texturing	4,344,996	LeRC
Lo I Yin, NASA/GSFC	Low intensity X-ray and gamma-ray imaging spectrometer	4,345,153	GSFC
Bruce L. Gary, Caltech/JPL	CAT altitude avoidance system	4,346,595	NRO/JPL
Paul M. Gammell, Caltech/JPL	Improved hyperthermia heating apparatus	4,346,715	NRO/JPL
Leland A. Imig and Mickey R. Gardner, NASA/LaRC	Heating and cooling system	4,346,754	LaRC
David B. Rhodes, NASA/LaRC	Scanning a focal laser velocimeter projection lens system	4,346,990	LaRC
Thomas J. Pivirotto, Caltech/JPL	Method and apparatus for convection control of metallic halide vapor density in a metallic halide laser	4,347,613	NRO/JPL

Space Shuttle Launches for 1982

Orbiter	Launch Date	Launch Site	Payload
*Columbia (OC-102)	March 22	KSC	OSS-1
*Columbia (OC-102)	June 27	KSC	DOD 82-1
Columbia (OV-102)	November 11	KSC	SBS-C, Telesat-E

* Successful launch

Expendable Launches for 1982

Name	Launch Date	Vehicle	Range	Mission Remarks
*RCA-C	January 15	Delta	ESMC	RCA communications. Reimbursable.
*Westar-IV	February 25	Delta	ESMC	Western Union communications. Reimbursable.
*Intelsat V-D	March 4	Atlas Centaur	ESMC	Intelsat communications. Reimbursable.
*Insat 1-A	April 10	Delta	ESMC	India communications. Reimbursable.
*Westar-V	June 8	Delta	ESMC	Western Union communications. Reimbursable.
*Landsat-D	July 16	Delta	WSMC	NASA earth resources applications.
*Telesat-G (Anik-Da)	August 26	Delta	ESMC	Canada communications. Reimbursable.
*Intelsat V-E	September 28	Atlas Centaur	ESMC	Intelsat communications. Reimbursable.
RCA-E	October 28	Delta	ESMC	RCA communications. Reimbursable.
Intelsat V-F	December	Atlas Centaur	ESMC	Intelsat communications. Reimbursable.
IRAS	December	Delta	WSMC	Infrared astronomy, NASA scientific. Reimbursable.

* Successful launch

Another Dividend from Air and Space

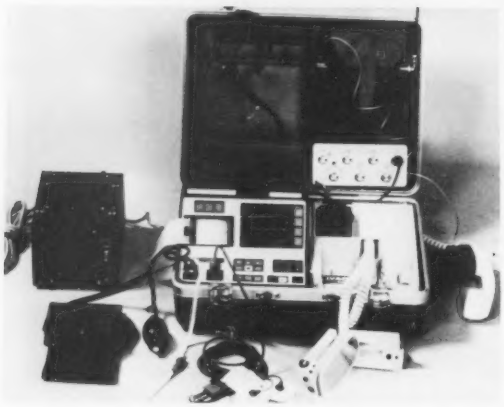
Research and development in aeronautics and space have provided numerous benefits for all Americans—and at a tiny percentage of the tax dollar. Here is an example:

Portable Medical System

Emergency medical treatment for heart attack victims in rural or remote areas, particularly important where considerable time may elapse before the patient reaches a hospital, has been made possible through a spinoff of aerospace medical technology. Called a Portable Medical Status and Treatment System,* this life-saving "briefcase" (photo below) displays pulse rate, temperature, blood pressure and respiration rate along with status information including heart rate and respiration alarms. The system also contains a defibrillator which can deliver electric shock in six different levels to restore rhythmic heartbeat.

A 10-channel radio equipped with two-way voice communication and the system's electronic capability of transmitting vital signs to a distantly located physician, allows the attendant at the emergency scene to diagnose and receive treatment instructions. The battery-powered portable medical system can operate up to 6 hours.

The Portable Medical Status and Treatment System was developed from an earlier NASA project known as the Physician's Black Bag, a



portable monitoring treatment unit developed for Johnson Space Center by Telecare, Inc., a company later acquired by Narco Scientific, Houston.

First units were delivered to the Department of Transportation last year and tested in two types of medical emergency environments—one in a rural Pennsylvania community and another aboard a U.S. Coast Guard rescue helicopter operating along Florida's Gulf Coast.

Narco also has developed a companion system called Porto-Fib III (photo above) with refined and expanded defibrillating and display functions designed for use in hospitals.

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* NASA does not endorse commercial products as a result of its Technology Utilization or Patent Licensing Programs, but it does encourage the widest possible use of its technology.

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National Aeronautics and Space Administration